Space Weather Technical Forecast

Issued on Thursday, 25 May 2023 at 13:25 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: R1/R2 radio blackouts Likely. Active fluence Expected. Slight chance of G1/Minor Storm intervals to end current UTC working week.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate over the last 24 hours, with X-ray flares recorded at GOES16 registering at occasional C-class, with a peak of an M1.8 flare from AR3311, peaking at 24/1721UTC. There are currently up to seven sunspot regions on the visible disc, with AR3311 now calving sunspot AR3314 to its immediate west, while a new sunspot group is potentially developing to the immediate north of AR3310.

Of the current sunspots, AR3311 in the north centre disc remains the largest and most complex region, with a Mt Wilson Delta spot persisting within the intermediate portion of the group, although some its previous complexity is now apportioned to AR3314, most significantly giving AR3310 a shorter span. AR3315 had developed rapidly in the period, with its constituent spots developing mature penumbrae and spreading, to leave the group as a Dai/Beta. AR3309 appears to be a relatively minor region in visible light in a slowly reconfiguring Bxi/Beta, however there is some arcing between this region and AR3310 to its west that may help explain some C-class activity in the former. AR3310 itself showed relatively minor changes in the past day, with some small spots mobile around the main symmetric leader, although a possible new region may be developing nearer the solar equator to its immediate north. Finally, AR3313 was relatively unchanged in the period.

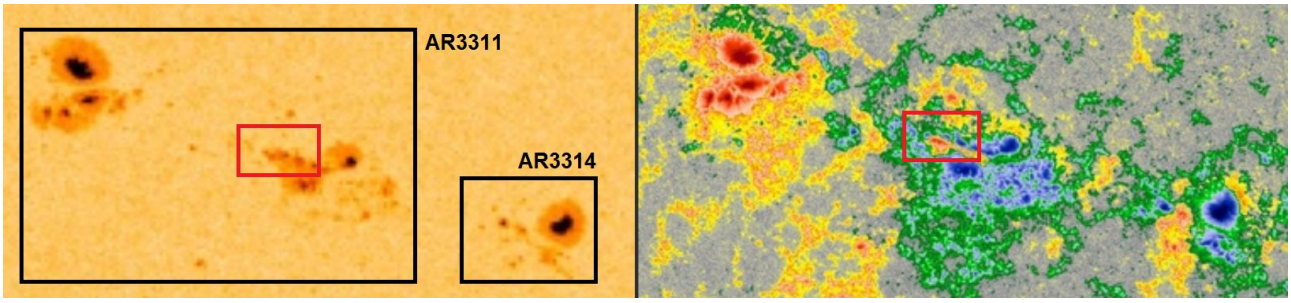

Figure 0: HMIIF and HMIBC imagery from 25/1200UTC, showing AR3311 and AR3314. The prospective Mt Wilson delta spot is shown boxed red, but has faded somewhat over the past 24 hours – matched by X-ray activity at the time of writing.

No Earth-directed CMEs were observed in available coronagraph imagery. Disappearing filaments from the northwest quadrant around 24/1200UTC and the southwest around 25/1030UTC do not yet show evidence of CMEs, and they may have been re-absorbed. A CME visible from around 25/0900UTC, apparently heading south and west appears to be far sided from cursory analysis.

Solar Wind / Geomagnetic Activity: Solar winds observed at L1 by ACE and DSCOVR have shown a fast wind regime, likely to be that from CH06/-, with the phi angle accordingly negative

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(towards the Sun). Solar wind speeds have shown a slight upward tendency through Elevated levels, rising from the low 500s to peak near 600km/s by the period's end. The solar wind density over the same period showed a level tendency in single figures ppcc, while the IMF was steady at or below 6nT, with a north-south component between +/-5nT.

The net result of the above solar wind measures was for mainly Unsettled geomagnetic activity, with a provisional peak of '3o' seen in several of the three-hour measuring intervals.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV), as measured at GOES16, has remained at Background levels throughout.

High energy electron flux (greater than 2MeV), as measured at GOES16, reached High levels, but with subsequent successive reductions, eventually as low as Normal Background levels. A maximum flux of 2700pfu was observed at 24/1605UTC. The 24-hour integrated fluence rose above Active levels from 24/1800UTC on a slight rising trend that then slowed, with 1.16e8 integrated pfu recorded at 25/0001UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is Likely to remain Moderate, with isolated to occasional M-class flares Likely and a Slight Chance of X-class flares. These most likely from the complex AR3311 or the quickly-developing AR3315. No sunspots leave the disc in the four days, and while there are suggestions of arrivals, these have yet to present for analysis over the eastern limb, and the risks are therefore held constant throughout.

Solar Wind / Geomagnetic Activity: There are no Earth-directed CMEs expected, although a weak CME that appears in some MOSWOC Enlil ensemble members may give some glancing influence on Days 2 or 3 (26 or 27 May).

Solar winds expected to remain at Elevated levels around 500-600km/s during Day 1 (25 May) due to the continued influence of the high speed stream from large coronal hole CH06/- in the southwest quadrant. Wind speeds are forecast to decline steadily from Day 2 (26 May) onwards towards background levels, although any decline may be temporarily inhibited by any possible CME glance.

Geomagnetic activity is forecast to decrease from its current peak, with an initial Chance of Active intervals most likely to have faded by the coming UTC weekend. More reliably Quiet conditions should then prevail for the second half of the period, assuming no new CMEs are emitted.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to remain at Background levels, but there is a slight chance of reaching the S1/Minor Storm threshold should any larger flares occur.

High energy electron flux (greater than 2MeV) is expected to continue to reach High levels at the diurnal peaks, with peaks likely rising through the period. The associated electron fluence is also likely to follow a rising trend, with Active (1e8 integrated pfu) conditions now expected through the period.

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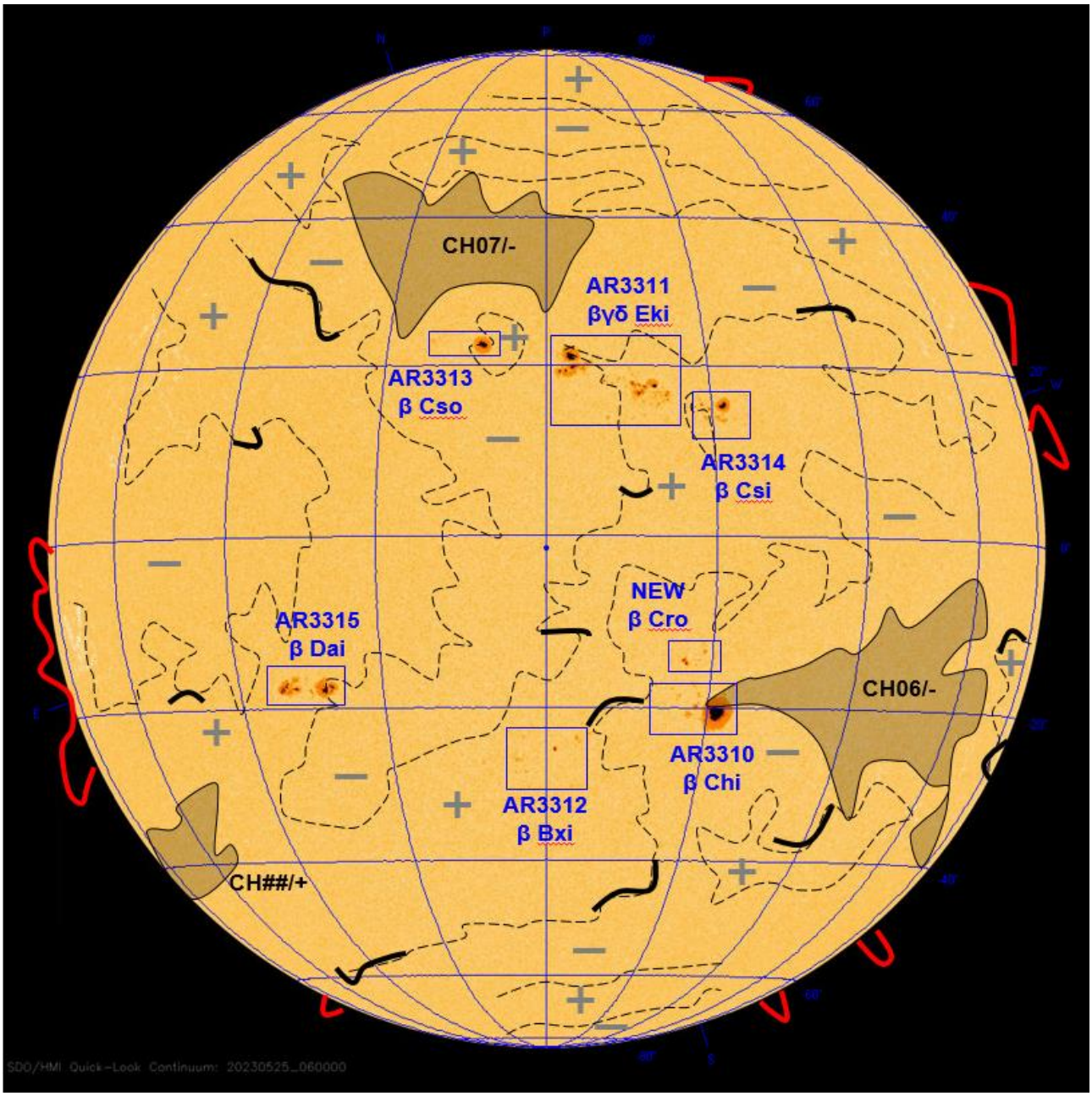
Figure 1. Solar Analysis Valid 25/0600UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There is a very slight chance of a CME which left the Sun on 22 May glancing Earth on Days 2 or 3 (26 or 27 May). The MOSWOC Enlil deterministic run has this as a miss, and this is the preferred forecast, however there is a suggestion in the ensemble of one or two narrow glances that warrant its inclusion as a mention - significant interaction is not expected. No further Earth-directed CMEs have been observed in available imagery.

Solar winds currently at elevated levels around 500-600km/s due to the influence of the high speed stream from large coronal hole CH06/- in the southwest quadrant, and expected to remain so through Day 1 (25 May). Wind speeds are then forecast to decline steadily from Day 2 (26 May) onwards towards Background levels. This is due to the waning influence of the high speed stream, although any decline may be temporarily inhibited by any possible CME glance - again, not the most likely scenario, which should otherwise see an uneventful exit from a fast to a slow regime.

Geomagnetic activity is forecast to decrease from its current peak, with an initial Chance of Active intervals most likely to have faded by the coming UTC weekend. More reliably Quiet conditions should then prevail for the second half of the period, assuming no new CMEs are emitted.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	1	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil, see ‘Geomagnetic Storm’ section for discussion.

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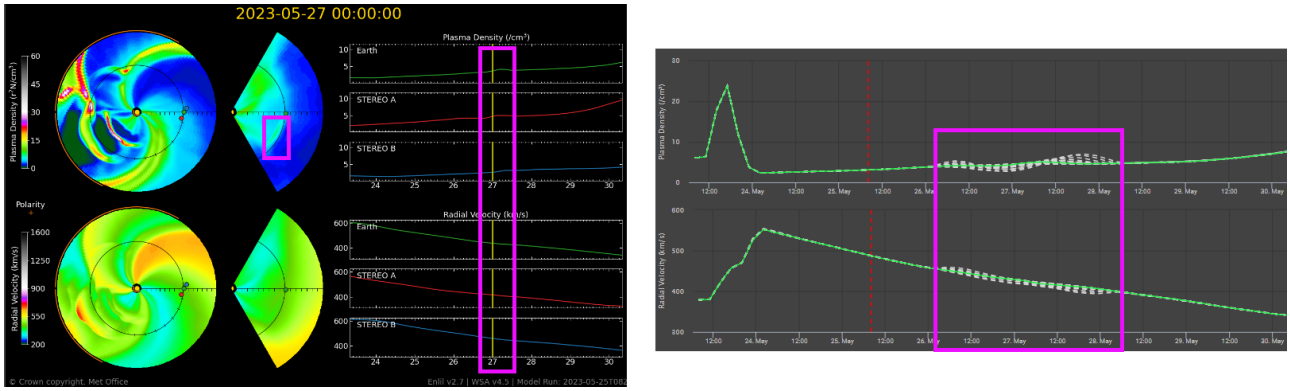
Figure 2: MOSWOC Enlil and ensemble, showing very marginal influence in some members from the 22 May southeast quadrant CME. This feature is due to cross 1AU below and behind the Earth (in the deterministic run) around the turn of the UTC day 26 into 27 May, although the spread of solutions is very large, as can be seen in the low, broad peaks in the ensemble.



Radio Blackouts - X-Ray Flares:

Of the current sunspot regions on the visible disc, AR3311 remains the largest and most complex region, with a small Mt Wilson Delta persisting. This region presents the bulk of the current flare risk as the source of multiple M-class flares in recent days. All of the current front side regions are contained within a relatively short angular distance from the central region of the Sun, and any X-ray flares need to be more closely scrutinised for any accompanying CMEs.

Solar activity is Likely to remain Moderate, with isolated to occasional M-class flares Likely and a Slight Chance of X-class flares. These most likely from the complex AR3311 or the quickly-developing AR3315. No sunspots leave the disc in the four days. In terms of possible arrivals, the Carrington locations for up to five returning regions are due in the four days, however until these present for analysis over the eastern limb the risks are held constant throughout.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**R1-R2 M Class**	Yes	60	60	60	60
Very Active	**R3 to R5 X Class**	No	10	10	10	10

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Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux, as observed by GOES16, is at Background levels and is currently expected to remain so throughout the period.

There is a small and gradually rising risk of enhancement should any larger flares occur, with this most likely from AR3311 or perhaps AR3315 as they rotate westward through the period, but also from regions that have recently rotated beyond the western horizon. As such, a Slight Chance of reaching the S1/Minor Storm threshold is maintained throughout.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	15	15
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

The high energy electron flux (greater than 2MeV) has been attenuated slightly in the past 24 hours, likely the result of continued Unsettled geomagnetic activity. Once this wanes, the most realistic scenario is felt to be flux levels diurnally reaching High, and fluence perhaps narrowly above Active, although confidence in this has fallen relative to earlier guidance given the periodic reductions in the past 24 hours at GEO, which may have redistributed some of the gains resulting from CH06. No CMEs feature in this rationale, nor any subsequent fast wind from CH07/-, for example.

The current MOSWOC REFM model output is viewed as good guidance, with narrowly Active levels the preferred forecast scenario.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	100	70	70	70
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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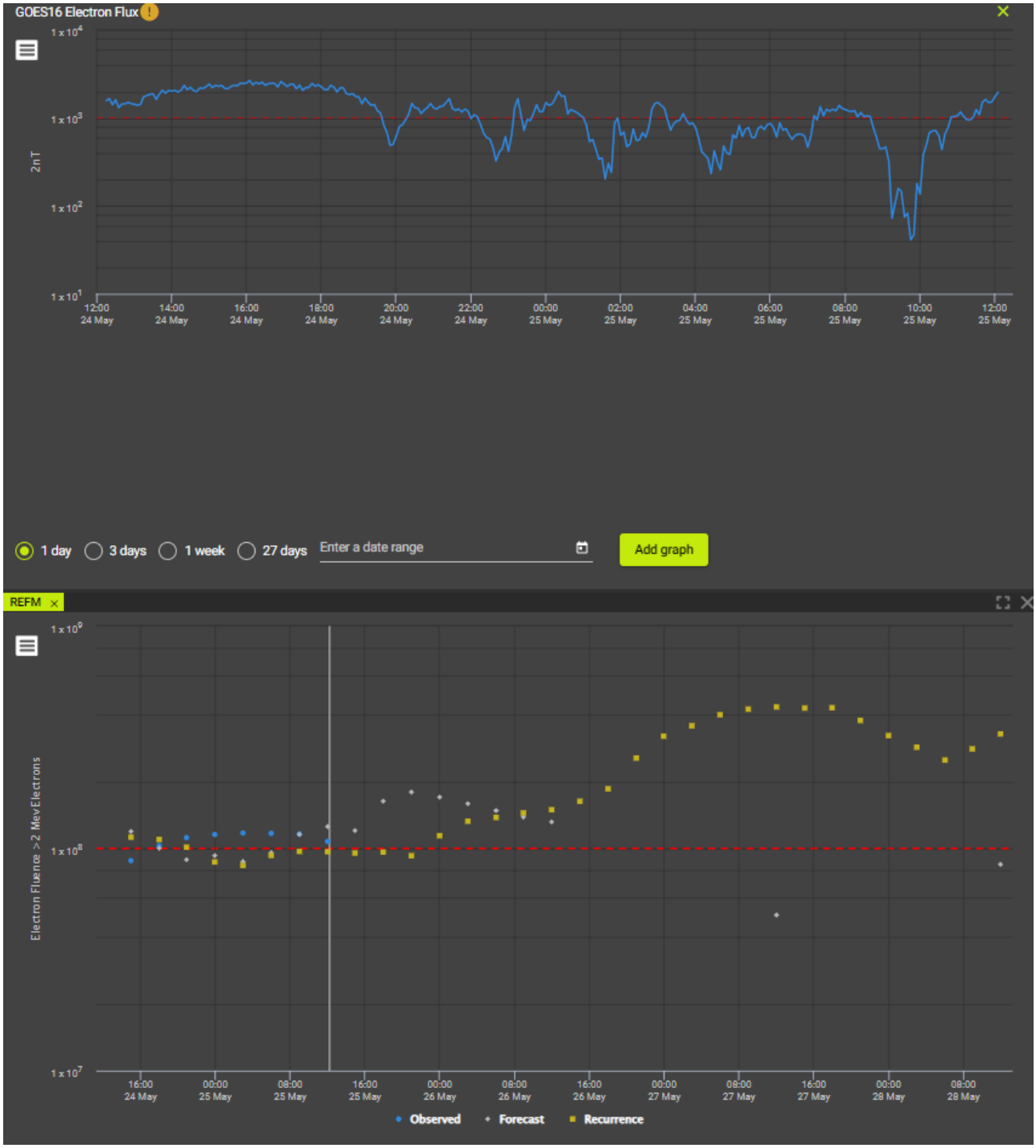
Figure 3: Past 24 hours in GOES16 high energy electron flux (greater than 2MeV), showing a generally High level, but with some attenuations at GEO due to Unsettled geomagnetic activity from the CH06 fast wind. MOSWOC REFM is felt to be offering a reasonable steer as to fluence in the coming three days, with the expected absence of interveneing CMEs and the similarity of CH06 to last pass.



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